GROUND-BASED CENTIMETER, MILLIMETER, AND SUBMILLIMETER OBSERVATIONS OF RECENT COMETS. S. N. Milam[1], Y. –L. Chuang[2], S. B. Charnley[1], Y. –J. Kuan[2,3], G. L. Villanueva[1,4], I. M. Coulson[5], and A. R. Remijan[6], [1]NASA Goddard Space Flight Center, Astrochemistry Laboratory, Code 691.0, 8800 Greenbelt Rd., Greenbelt, MD 20771, USA (email: stefanie.n.milam@nasa.gov), [2]National Taiwan Normal University, 88, Sec. 4, Ting-Chou Rd., Taipei 116, Taiwan, [3]Institute of Astronomy & Astrophysics, Academia Sinica, 1, Sec. 4, Roosevelt Rd., Taipei 106, Taiwan, [4]Catholic University of America, 620 Michigan Ave NE Washington, DC, USA, [5]Joint Astronomy Center, P.O. Box 1104, Keaau, HI 96749, USA, [6]National Radio Astronomy Observatory, 520 Edgemont Road, Charlottesville, VA 22903 USA.

Introduction: Comets provide important clues to the physical and chemical processes that occurred during the formation and early evolution of the Solar System, and could also have been important for initiating prebiotic chemistry on the early Earth [1]. Comets are comprised of molecular ices, that may be pristine interstellar remnants of Solar System formation, along with high-temperature crystalline silicate dust that is indicative of a more thermally varied history in the protosolar nebula [2]. Comparing abundances of cometary parent volatiles, and isotopic fractionation ratios, to those found in the interstellar medium, in disks around young stars, and between cometary families, is vital to understanding planetary system formation and the processing history experienced by organic matter in the so-called interstellar-comet connection [3].

In the classical picture, the long-period comets probably formed in the nebular disk across the giant planet formation region (5-40 AU) with the majority of them originating from the Uranus-Neptune region. They were subsequently scattered out to the Oort Cloud (OC) by Jupiter. The short-period comets (also known as ecliptic or Jupiter Family Comets - JFC) reside mainly in the Edgeworth-Kuiper belt where they were formed. Given the gradient in physical conditions expected across this region of the nebula, chemical diversity in this comet population is to be expected [4,5]. We have conducted observations of comets 103P/Hartley 2 (JFC) and C/2009 P1 (Garradd) (OC), at primarily millimeter and submillimeter wavelengths, to determine important cosmogonic quantities, such as the ortho:para ratio and isotope ratios, as well as probe the origin of cometary organics and if they vary between the two dyanamic reservoirs.

Observations: Observations were conducted from four facilities, including: Arizona Radio Observatory's 12m telescope, Kitt Peak, AZ, and Submillimeter telescope, Mt. Graham, AZ, as well as the James Clerk Maxwell Telescope, Mauna Kea, HI and the Greenbank 100m telescope, Greenbank, WV, covering 20 cm, 3 cm, and 0.8-3 mm. Data were obtained, simultaneously when possible at all facilities and collected in position switching mode with spectral resolutions of *dv* ~0.05 – 0.6 km/s. Ephemerides were generated from JPL Horizons daily and positional accuracy was monitored approximately every hour by pointing/focusing on nearby planets and/or quasars.

Results and Discussion: We report multiwavelength spectral observations of comets from two dynamical families including the JFC 103P/Hartley 2 and the OC comet C/2009 P1 (Garradd). Multiple parent volatiles (e.g. HCN, CH_3OH, CO) as well as daughter products (e.g. CS and OH) have been detected in these objects. We will present a comparison of molecular abundances in these comets to those observed in others, supporting a long-term effort of building a comet taxonomy based on composition.

References: [1] Ehrenfreund, P. & Charnley, S. (2000) *ARA&A, 38,* 427. [2] Wooden, D. (2008) *SpSciRev., 138,* 75. [3] Ehrenfreund, P. et al. (2004) in COMETS II, eds. M. Festou, H.U. Keller & H.A. Weaver, Univ. Arizona Press, p. 115. [4] Crovisier, J. et al. (2009) *EM&P, 105,* 267. [5] DiSanti, M. & Mumma, M. (2008) *SpSciRev., 138*, 127.

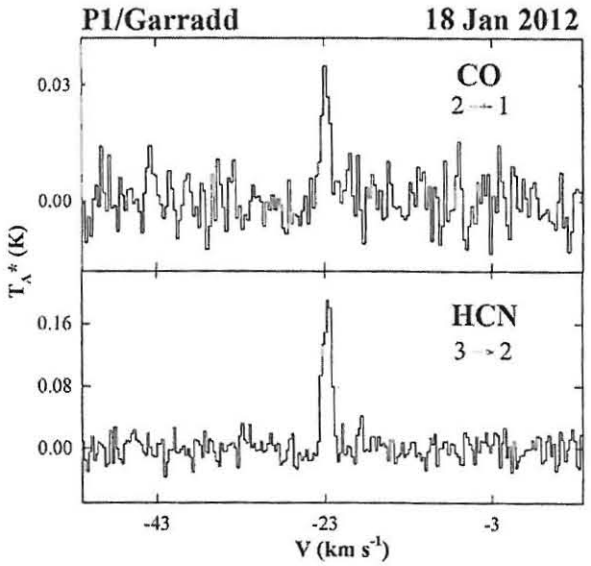

Figure 1: Detection of HCN and CO in comet Garradd on 18 Jan 2012 with the SMT.